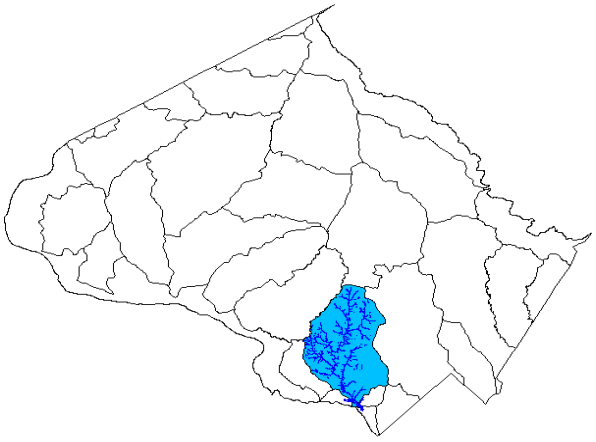
CABIN JOHN CREEK

WATERSHED STUDY

Montgomery County
Department of Environmental Protection
Watershed Management Division

June 9, 1999



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Cabin John Creek Watershed

Introduction to the Watershed

The Cabin John Creek watershed is within the Potomac River drainage in southern Montgomery County (Figure 1). The watershed, located in the piedmont ecoregion, occupies approximately 16,022 acres. Cabin John Creek originates within the city of Rockville and flows in a southerly direction to a confluence with the Potomac River between the Little Falls dam and Great Falls. The Watershed is bounded by Rockville Pike (Rt. 355) and Old Georgetown Pike (Rt. 187) to the east and Falls Rd.(Rt. 189) to the west (Figure 1).

The watershed has been significantly impacted by suburban development patterns centered around the County's main transportation corridors (CSPS, Rowe et al.,1997) (Figure 1). The Interstate 495/270 corridor passes through the central part of the watershed, and commercial and high density residential development are common along this corridor, particularly affecting the eastern tributaries. Rockville Pike and the City of Rockville occupy the headwaters of Cabin John. In contrast, the western tributaries transition to lower density residential communities with far less commercial development. On-site stormwater runoff controls are uncommon in Cabin John. Like many downcounty watersheds, this area developed before environmental regulations for stream buffers and stormwater management went into effect. The mainstem of Cabin John Creek is protected within the County's stream valley park system, and to some extent, the western tributaries also benefit from parkland buffers, particularly Buck Branch. However, drainage from highly impervious areas in many tributaries has a detrimental effect on habitat quality and stream conditions within the park.

Analysis of the 1996 Stream Monitoring and Habitat Data

Resource Condition

The overall resource condition of Cabin John Creek was determined by assessing the cumulative impacts that occurred in the watershed as indicated by the use of an interim Index of Biological Integrity (IBI) for freshwater fish and benthic macroinvertebrates (Figure 2). A yearly assessment of "excellent", "good", "fair", or "poor" resource condition was made by examining the trends expressed by the two IBI's. This is not the same as averaging the two scores. Seasonal trends were examined and a yearly stream condition was established for the subwatersheds. Resource conditions were evaluated for 13 subwatersheds. Buck Branch and Ken Branch received an overall resource condition of *good.* Snakeden Branch, Thomas Branch, and Booze Creek received an overall resource condition rating of *poor*. The entire mainstem received an overall resource condition assessment of *fair*.

Cabin John Creek Mainstem

The upper, middle, and lower mainstem stations (CJCJ302, CJCJ303, CJCJ305, and

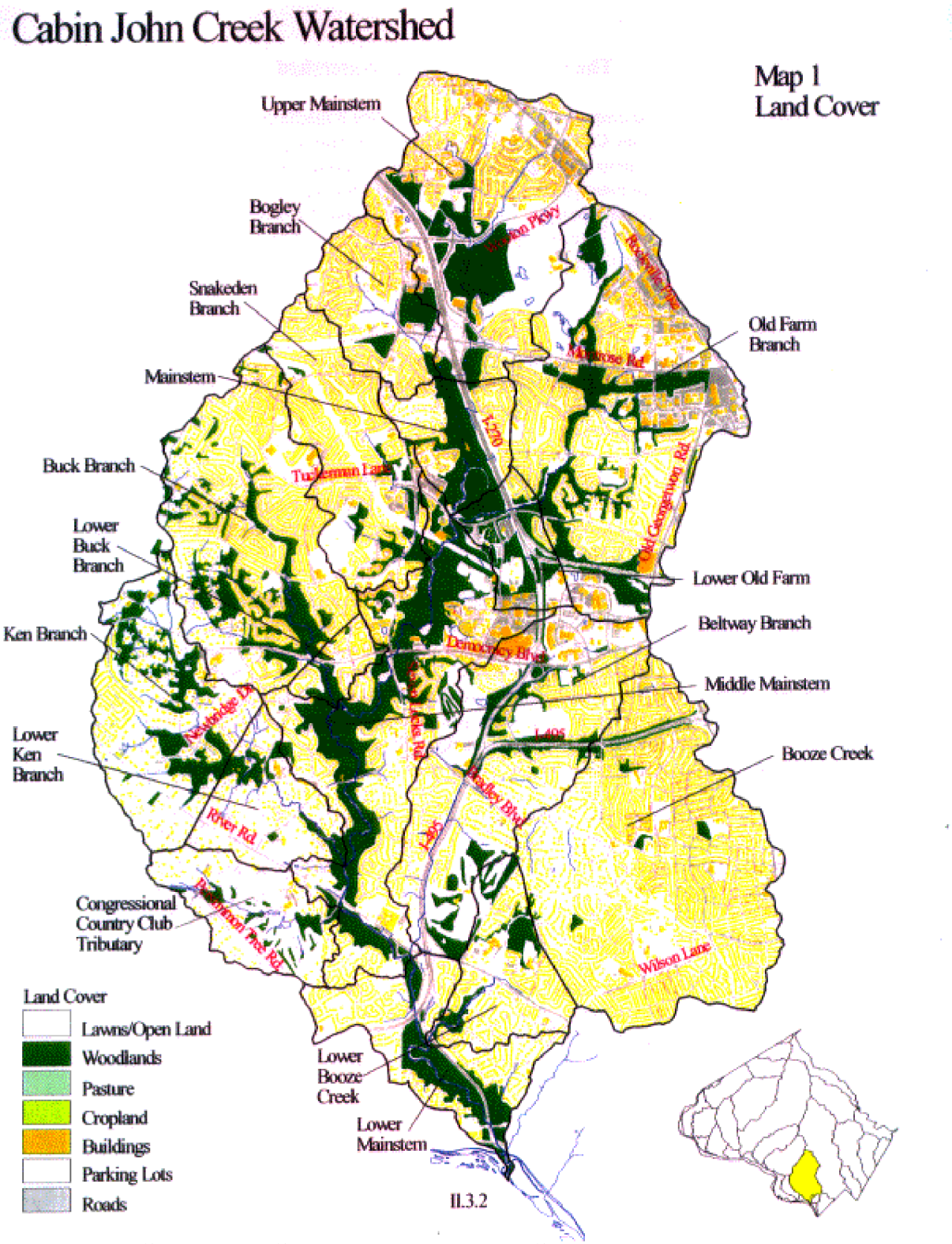


Figure 1. Cabin John Creek Watershed Land Cover.

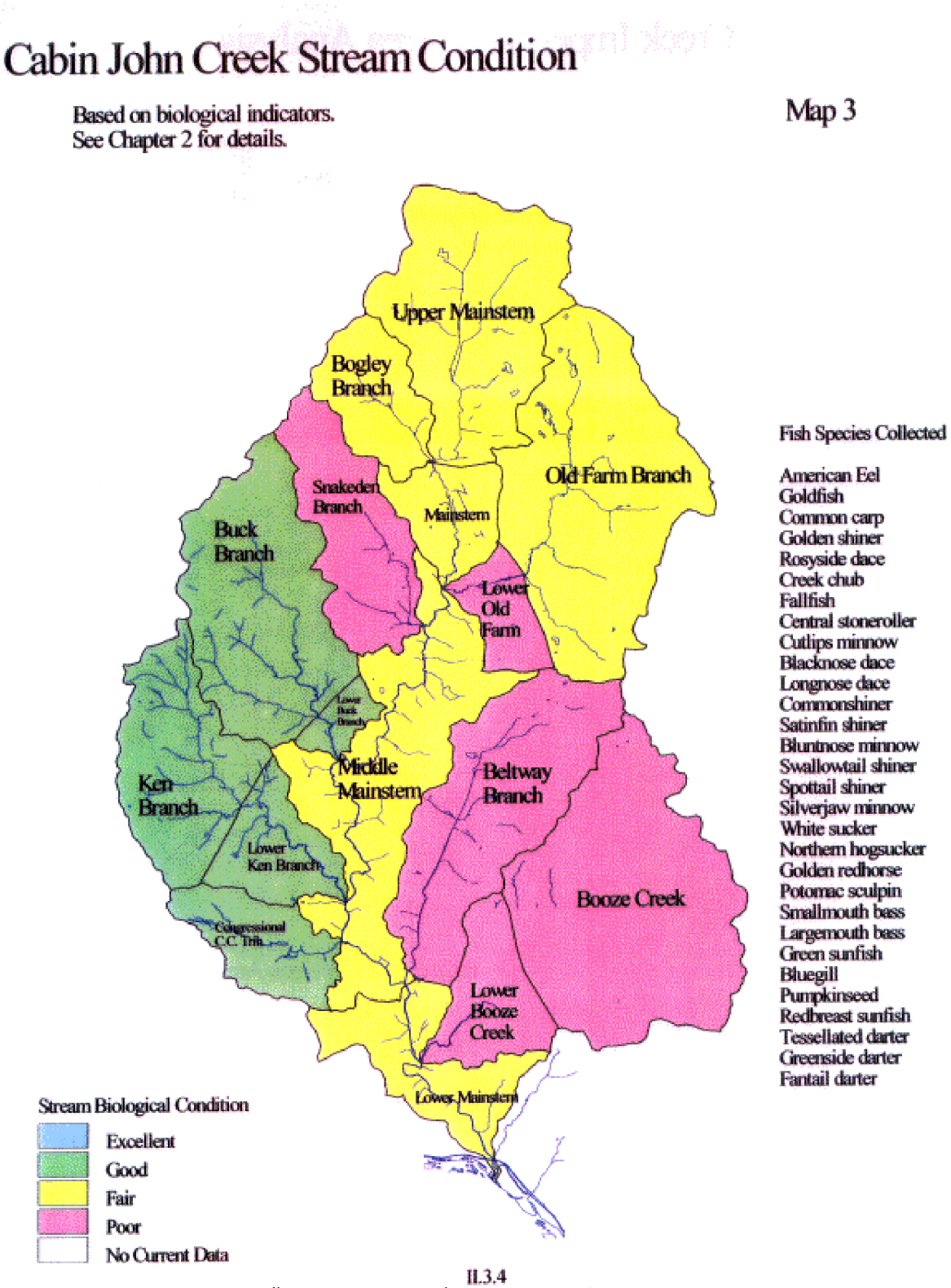


Figure 2. Stream Condition Map of Cabin John Creek.

CJCJ307) received a resource condition score of *fair* (Figure 2). Interim biological index scores for benthic macroinvertebrates were generally lower than fish index scores. Qualitative habitat condition was rated as *good* in the upper and lower sections. The habitat in the middle section of Cabin John was rated as *fair*.

Buck Branch and Ken Branch

Two western tributaries Buck Branch (CJBB201) and Ken Branch (CJKB201) received an overall resource condition rating of *good* (Figure 2). The qualitative habitat condition of Buck Branch was on the margin between *good* and *fair* overall. Ken Branch habitat condition was rated as *fair*.

Snakeden Branch, Thomas Branch, and Booze Creek

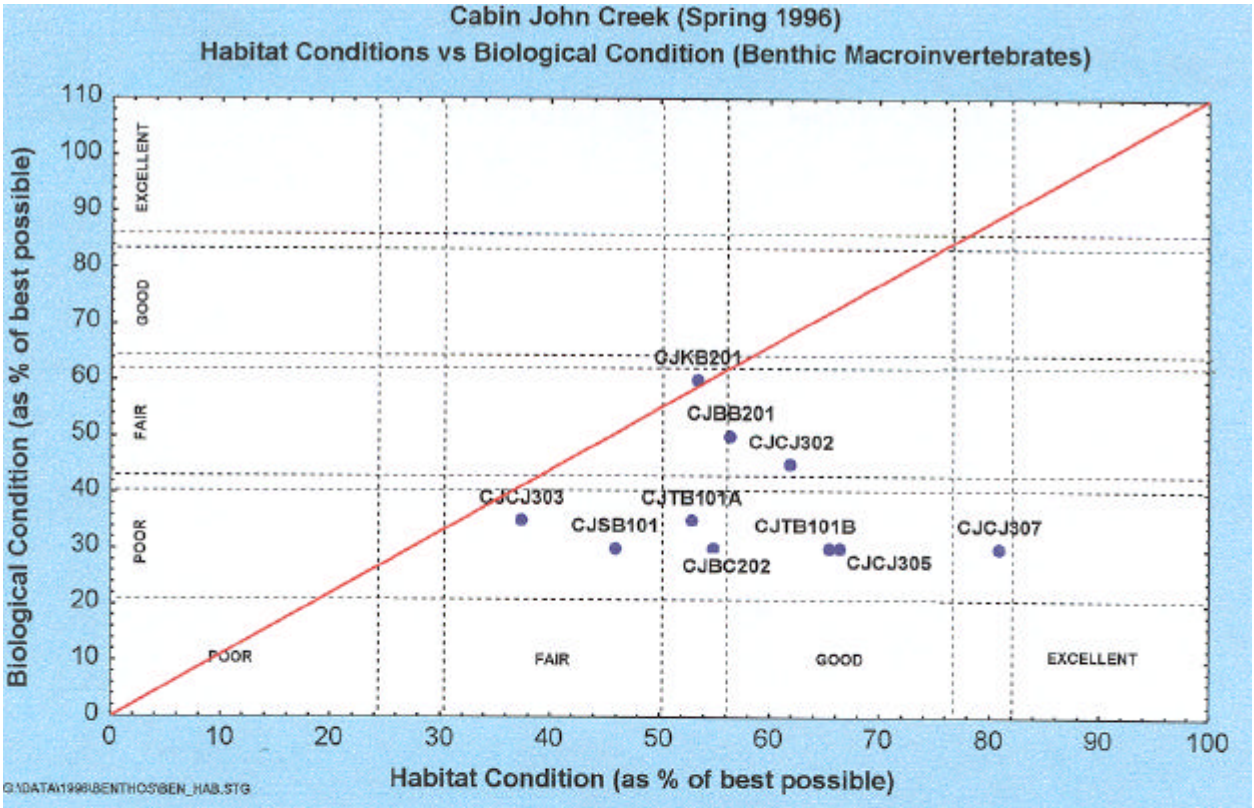
The Snakeden Branch (CJSB101), Thomas Branch (CJTB101a an CJTB101b), and Booze Creek (CJBC202) tributaries received an overall resource condition rating of *poor* (Figure 2). The qualitative habitat conditions at each of these tributaries was rated as *fair*.

Examination of IBI/Qualitative Habitat Relationships

Ten stations were monitored in Cabin John Creek in 1996. Benthic macroinvertebrates were collected in April. Fish surveys were conducted during September. Assuming that water quality is constant throughout the study area, the relationship between habitat quality and biological condition can be predictable, (Barbour et al, 1998), and provide diagnostic information on stressors likely responsible for identified impairment to the existing stream area (Figure 3). Possible causes of impairment can be determined by examining the relationship between the IBI score/habitat score for each individual monitoring station (Figure 3).

The benthic macroinvertebrate community IBI scores were either *fair* to *poor* throughout the watershed indicating an impaired benthic macroinvertebrate community. Stations CJCJ303, CJSB101, CJCJ302, CJBB201, and CJKB201 plot closely to the expected biological condition/habitat condition regression line (Figure 3). For these stations, the likely cause of impairment to the biological community is the current habitat condition.

Stations CJTB101a, CJBC202, CJTB101b, CJCJ305, and CJCJ307 deviate from the expected biological condition/habitat condition regression line and cluster in an area of the graph which reflects good to excellent habitat conditions but poor to fair IBI scores (Figure 3). These stream reaches should have a better benthic macroinvertebrate community because the habitat condition indicates support for good to excellent biological integrity. Evaluation of the individual parameters used for the qualitative habitat assessments further indicate that there are observed problems with embeddedness, sediment deposition, and bank stability. Uncontrolled runoff at the older developments have probably contributed to the current sediment erosion and deposition problems occurring within the stream channel. Heavy winter rains producing flood events that resulted in erosive flows during the winter/spring of 1996 (USGS 1996) may also



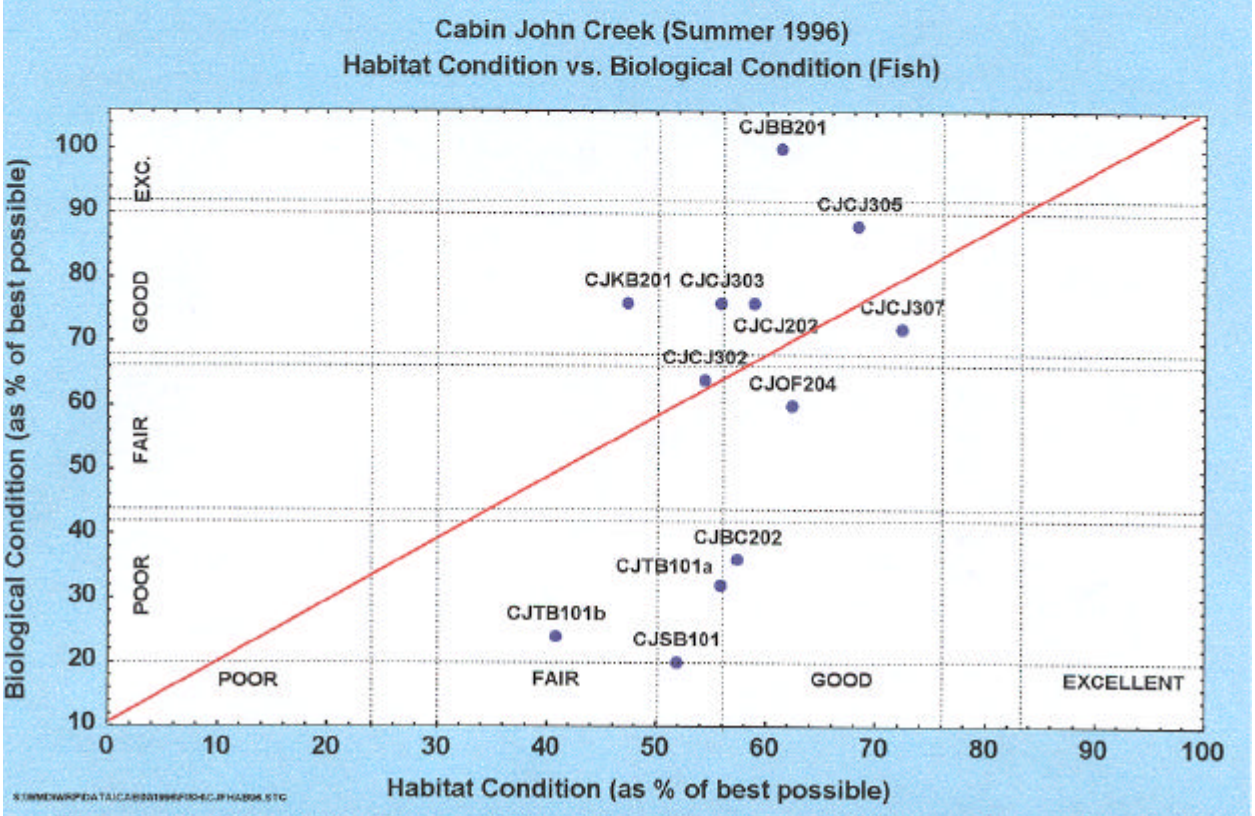


Figure 3. Identification of Possible Causes of Stream Impairment Using Habitat vs Biological Condition Relationships.

have had a significant impact on the benthic communities.

The fish community IBI scores ranged between the excellent to poor IBI classes (Figure 3). All but five station scores plot very close to the expected IBI/habitat regression line (Figure 3). Stations CJSB101, CJBC202, CJTB101a, and CJBB201 deviate from the expected IBI/habitat regression line and cluster in areas of the graph which reflects either good to excellent habitat conditions with poor to fair IBI scores (stations CJSB101, CJBC202, CJTB101a), or fall in areas of the graph with lower habitat scores than would be expected with the very high IBI score (CJBB201) (Figure 3). Stations CJSB101, CJBC202, CJTB101a should have a better fish community because the habitat condition indicates support for good to excellent biological integrity. Evaluation of the individual parameters used for the qualitative habitat assessments indicate that there were observed problems with embeddedness, sediment deposition, and bank stability even though the overall habitat assessment was scored as either good or excellent.. Uncontrolled runoff at the older developments have probably contributed to the current sediment erosion and deposition problems occurring within the stream.

Station CJBB201 supports a somewhat higher fish community (IBI = excellent) than the habitat alone (habitat score = good) would indicate (Figure 3). Nutrient enrichment may be present in this subwatershed of Cabin John. Elevated nutrients could be supporting a higher number of tolerant benthic macroinvertebrates than habitat alone would support. In turn, the insectivorous constituent of the fish community would be maintained by the more abundant benthic macroinvertebrates and the fish IBI score would reflect this condition. However, this condition could also be caused if the aquatic habitat was only recently impaired, and the fish and benthic communities were still reflecting the previous high quality habitat conditions. The later is doubtful because examination of the spring benthic macroinvertebrate habitat to IBI relationship (Figure 3) shows that the habitat of station CJBB201 was assessed as good while the benthic IBI score was also assessed as good. No recent habitat impairment is evident. Followup water chemistry monitoring will be conducted at this station during 1998. A base flow grab sample will be taken during mid-May to check for any elevated nutrient loads.

All other stations had good fish IBI community scores with corresponding good habitat scores (Figure 3), no impairment would be indicated at these stations.

Stations that demonstrate possible impairment in both the spring benthic macroinvertebrate community and the fish community indicate areas of impairment from other than habitat stressors that are not of a seasonal or temporary nature. These area will need to have follow up field work to investigate likely causes of impairment and to initiate corrective actions when causes are identified. Areas in Cabin John that meet this criteria include Upper Thomas Branch (CJTB101a), Bucks Branch (CJBB201), and Upper Booze Creek (CJBC202) (Figure 3).

Quantitative Habitat Analysis

Quantitative habitat was surveyed at 10 stations during the winter of 1997. Analysis of these measurements may provide further information as to whether or not a habitat limitation, physical impairment, or water quality impairment is potentially influencing the fish and benthic

macroinvertebrate communities.

Cabin John Creek Mainstem

Surveys conducted on the mainstem (CJCJ302, CJCJ303, CJCJ305, and CJCJ307) indicate an incised and widened stream channel with entrenchment ratios ranging from 1.1:1 to 1.7:1 (Figure 4 to 7). The term "entrenchment ratio" is the ratio of the width of the flood-prone area to the surface width of the bankfull channel, and expresses the vertical containment of a stream (Rosgen, 1996). The flood prone area is defined as the active floodplain and the first terrace level. These entrenchment ratios are indicative of a severely to moderately entrenched stream channel. This stream system does not currently have flood prone areas that are associated with relatively frequent storm events.This means that floods of up to the 50 year expected frequency flood are contained in the stream channel instead of dissipating energy over the floodprone area. Erosive velocities are directed against the stream banks with resulting high levels of bank erosion and sedimentation (Rosgen, 1996).

Bankfull width to depth ratios are another important indicator of trends in channel stability and overall stream habitat condition. Stream reaches with high bankfull width/depth ratios tend to have the in-stream hydraulic stress placed in close proximity to the stream banks. As width/depth ratios increase, the stress against the stream banks also increases. Bank erosion is further accelerated. Increased sediment supply to the stream channel develops. By virtue of becoming over widened, the channel gradually loses its capability to transport the increased sediment loads. Sediment deposition occurs in the channel and further accelerates bank erosion.

Width/depth ratios in the mainstem Cabin John range from 22:1 to 31:1. These ratios indicate an overly widened channel. These widened and entrenched stream channel areas are highly likely to be experiencing the accelerated bank erosion and sedimentation problems outlined above.

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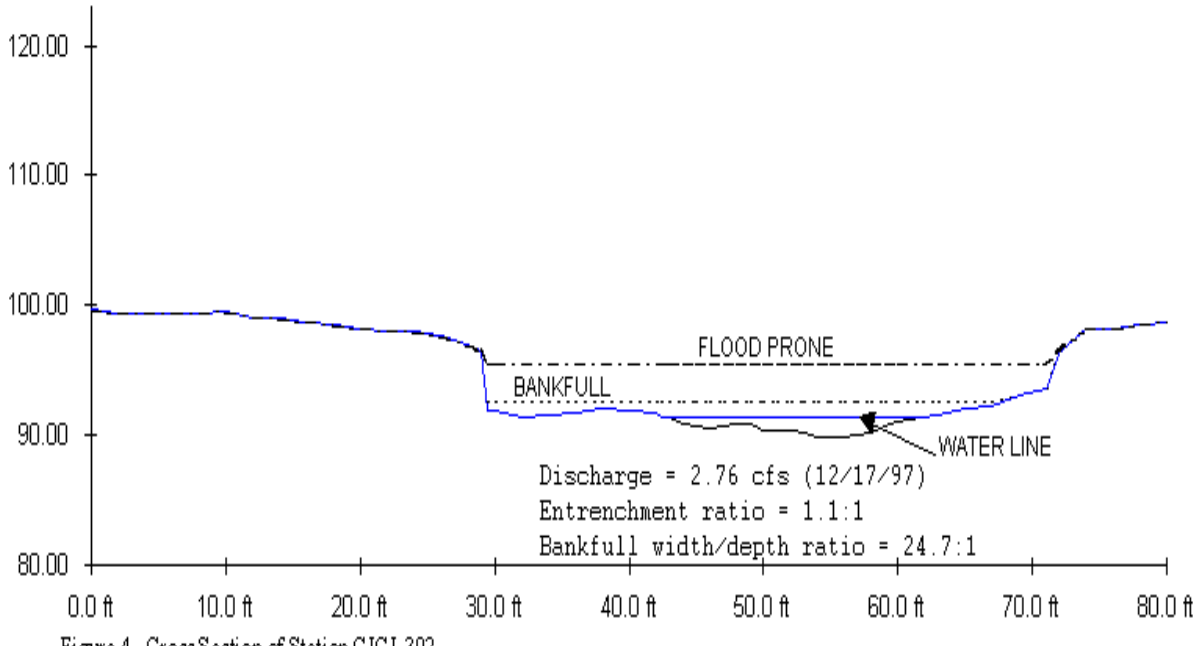
Pebble counts taken from the riffle bottom substrate ranged from a D_{50} of coarse gravel to small cobble for riffle substrate in the mainstem (Figure 8). The D_{50} expresses the size particle that 50% of the riffle substrate falls under. In other words, 50% of the riffle particles measure in the coarse gravel to small cobble size or less. Although this particle size is not ideal, it is large enough to sustain a benthic community. The average embeddedness estimates of these riffles is 65%. This moderate embeddedness level is enough to impair the resident benthic communities. Embeddedness is a measure of how much fine sediment surrounds the larger rocks of riffles and runs. If embeddedness levels are to high (>50%), the fine sediments can severely impact the available riffle habitat for benthic macroinvertebrates and fish.

Buck Branch and Ken Branch

The surveys conducted on the western tributaries Buck Branch (CJBB201) and Ken Branch (CJKB201) also indicate a highly incised channel with entrenchment ratios of 1.3 at each



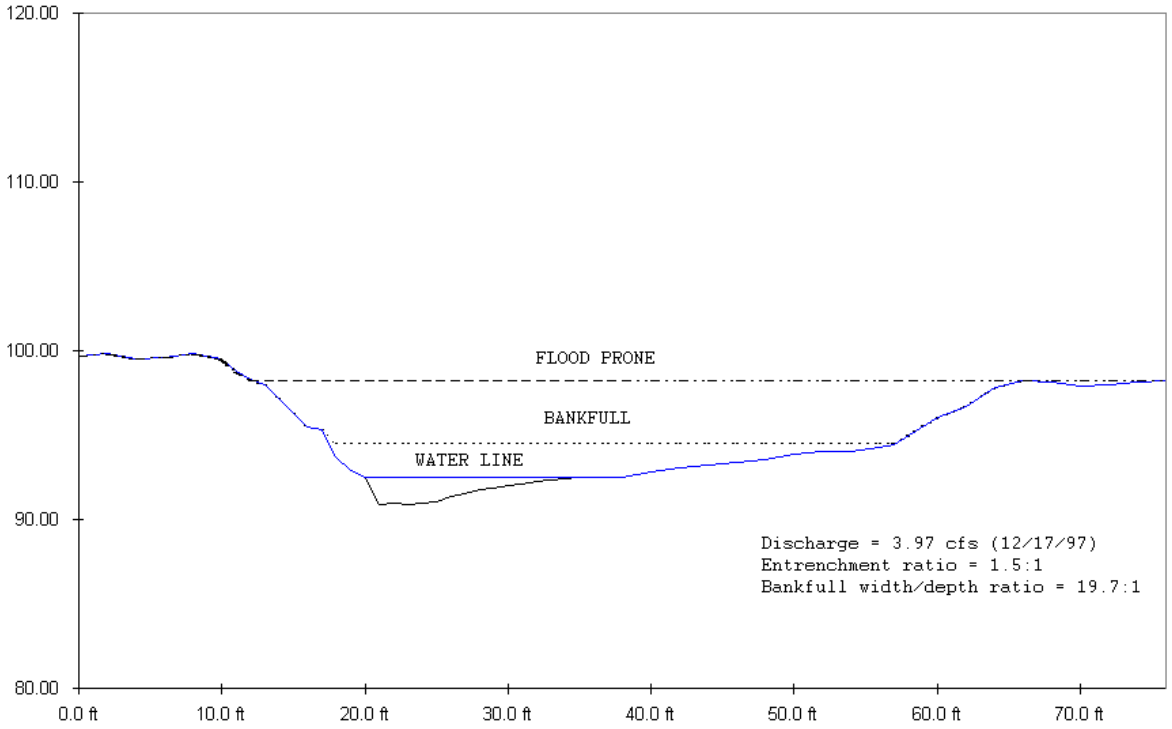
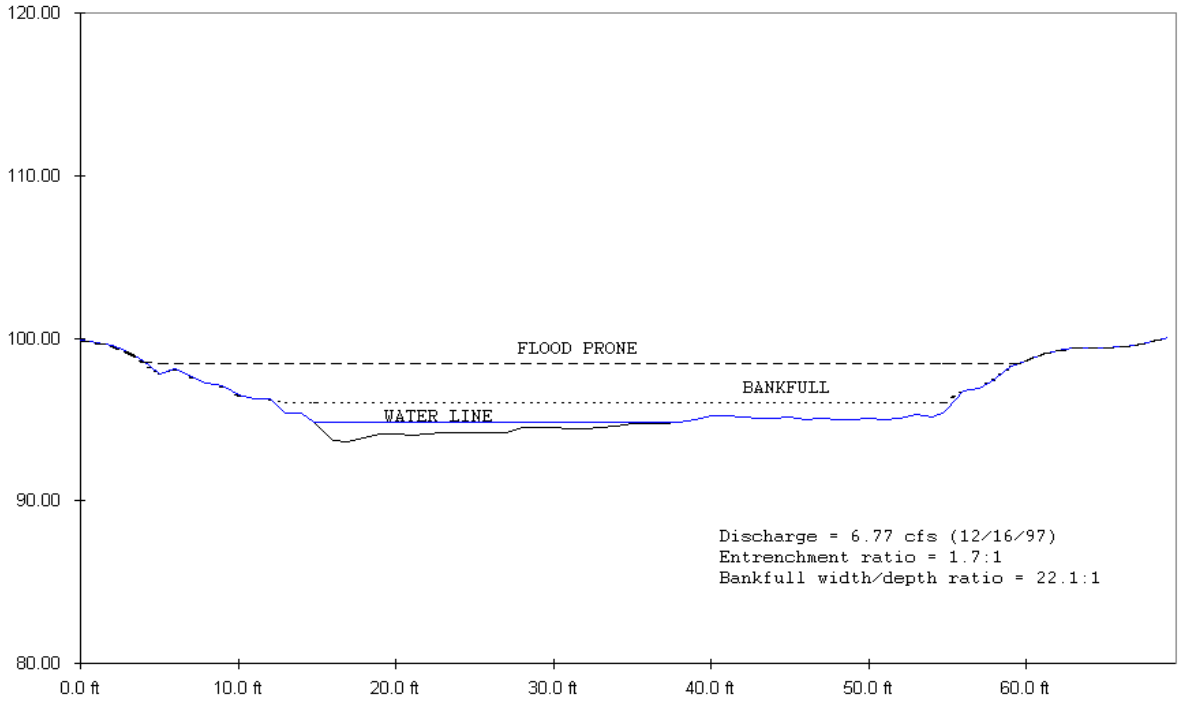


Figure 5. Cross Section of Station CJCJ-303



CJCJ-307

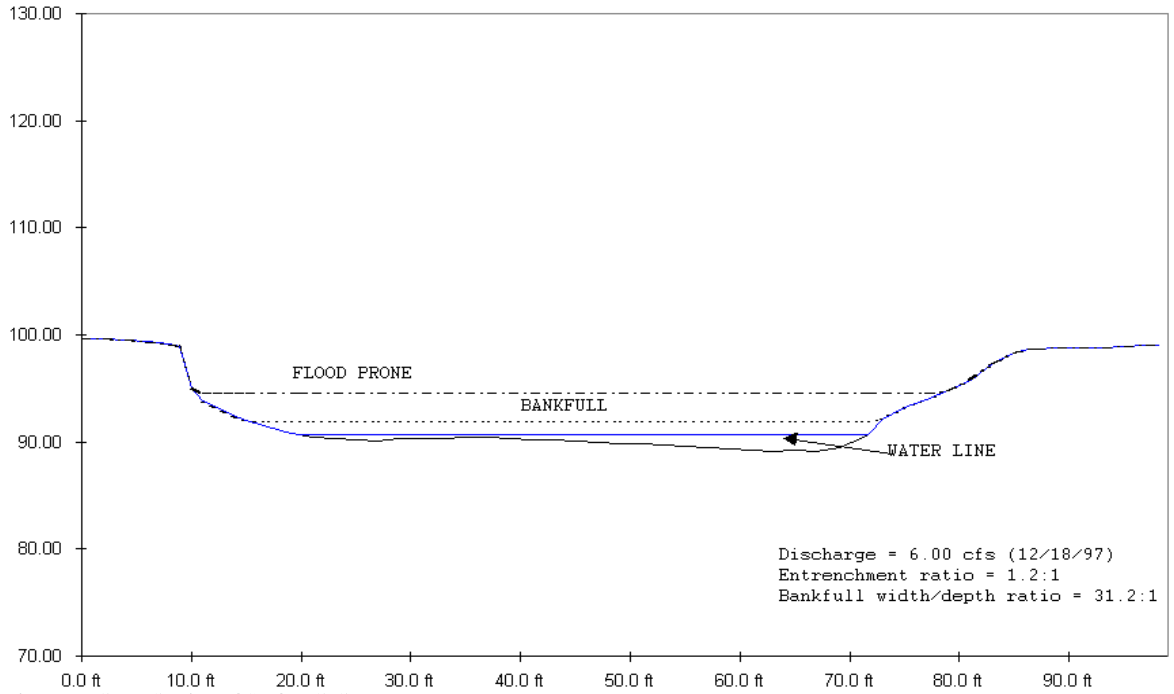


Figure 7. Cross Section of Station CJCJ-307.

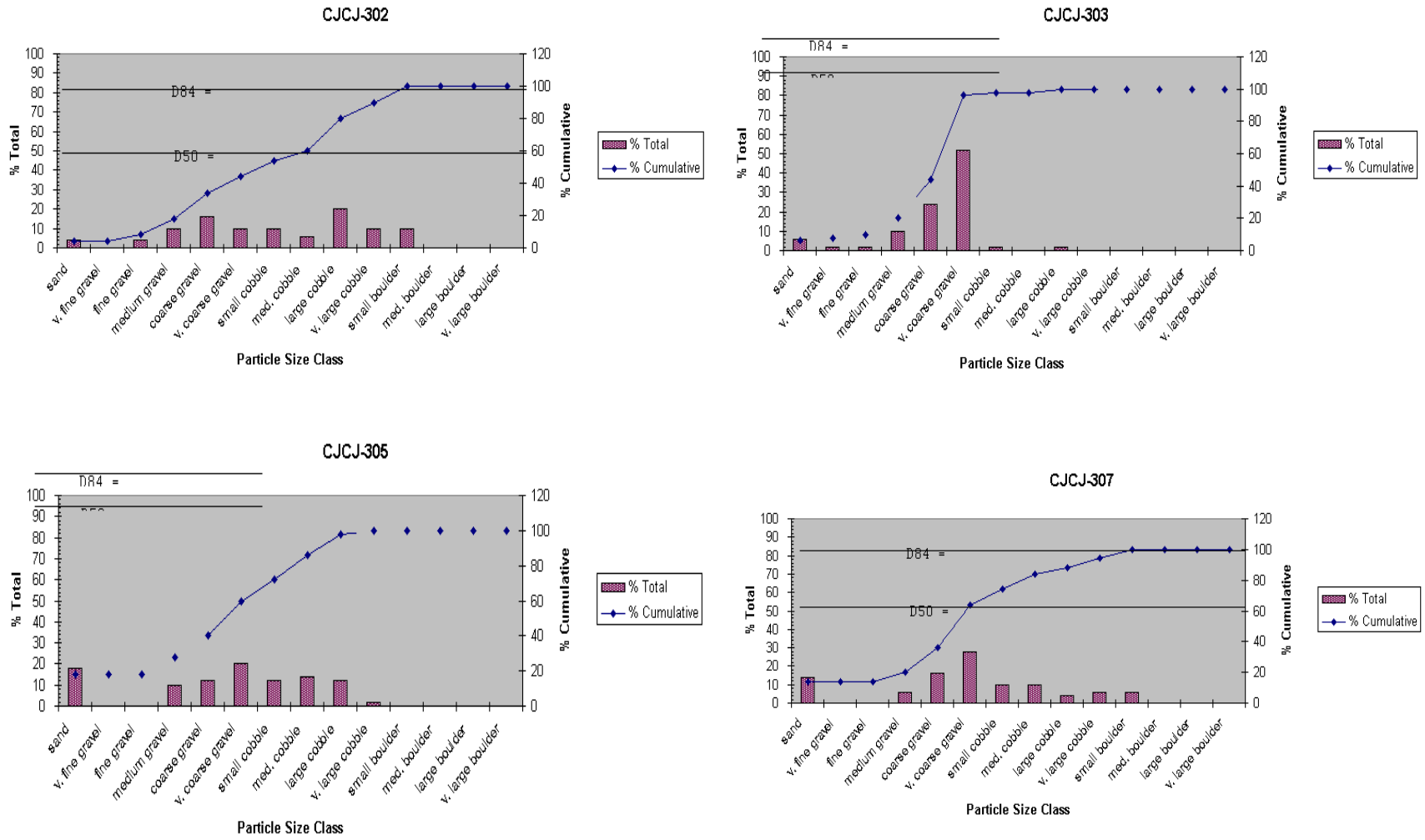


Figure 8. Riffle Particle Size Distribution for the Cabin John Watershed Main Stem Monitoring Stations, 1996.

tributary (Figure 9). The entrenchment ratio of 1.3 indicates a severely entrenched stream channel. Width/depth ratios of 22 at Buck Branch (CJBB201) and 16 at Ken Branch (CJKB201) indicates an overly widened channel. These tributary channels indicate the same problems of accelerated bank erosion and sedimentation as the main stem stations.

The pebble counts resulted a D_{50} of very fine gravel at Buck Branch (CJBB201) and coarse gravel Ken Branch (CJKB201) (Figure 10). The particle sizes in the riffle substrate in Buck Branch provide limited habitat for benthic macroinvertebrates. Particle sizes are a little less limiting at Ken Branch.

Snakeden Branch, Thomas Branch, and Booze Creek

Cross section analysis of the Snakeden Branch (CJSB101), Booze Creek (CJBC202) (Figure 11), and Thomas Branch (CJTB101a) and (CJTB101b) tributaries (Figure 12) also indicate incised channels in these tributarys. Entrenchment ratios ranged from 1.1-1.7 at these stations indicating severely entrenched stream channels. Bankfull width depth ratios ranged from 14:1 to 24:1 indicating overly widened stream channels.

Pebble counts ranged from a D_{50} of coarse gravel to very coarse gravel (Figure 13). Habitat for benthos would be expected to be slightly limited in this particle size substrate.

Water Temperature Monitoring

Three continually recording temperature meters were placed in the Cabin John Creek mainstem during August through September 1996. Temperature meters were distributed at stations CJCJ202, CJCJ302, and CJCJ307. All stations from the top to bottom of the watershed exhibited temperatures well within the State of Maryland's Use classification standard for Class I streams (Figure 14 (90^{o} F)). Although Cabin John is not classified a class IV put-and-take trout stream by the state, the temperatures also did not exceed the Use IV temperature criteria (75^{o} F) during this time period.

Discussion

Much of the Cabin John Creek watershed is located in the County’s stream valley park system. The stream buffer area provided by the park helps to control stream temperatures and to cleanse runoff quality in areas where runoff can be spread out over the buffer’s length. However, stream buffers by themselves do not generally have much effect in mitigating impacts associated with the excessive runoff from areas of the watershed that developed without any stormwater management controls. All subwatersheds monitored had severe to moderate entrenchment and had overly widened stream channels. Results of the quantitative habitat assessments indicate accelerated bank erosion and increased channel sediment deposition in many areas of Cabin John. A comprehensive watershed restoration and management approach is needed to materially improve stream conditions in Cabin John.

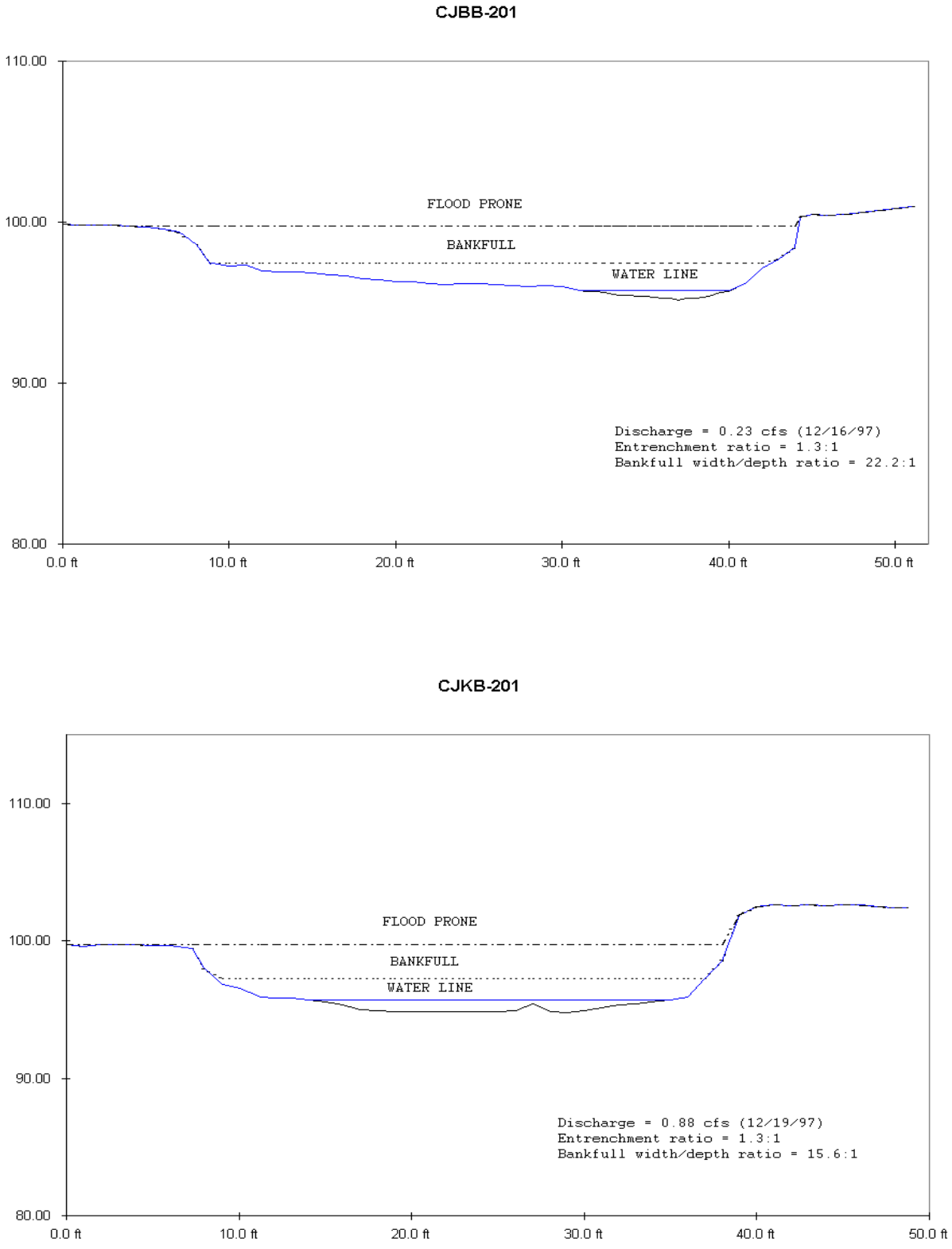


Figure 9. Cross Sections of Buck Branch and Ken Branch Monitoring Stations, 1996.

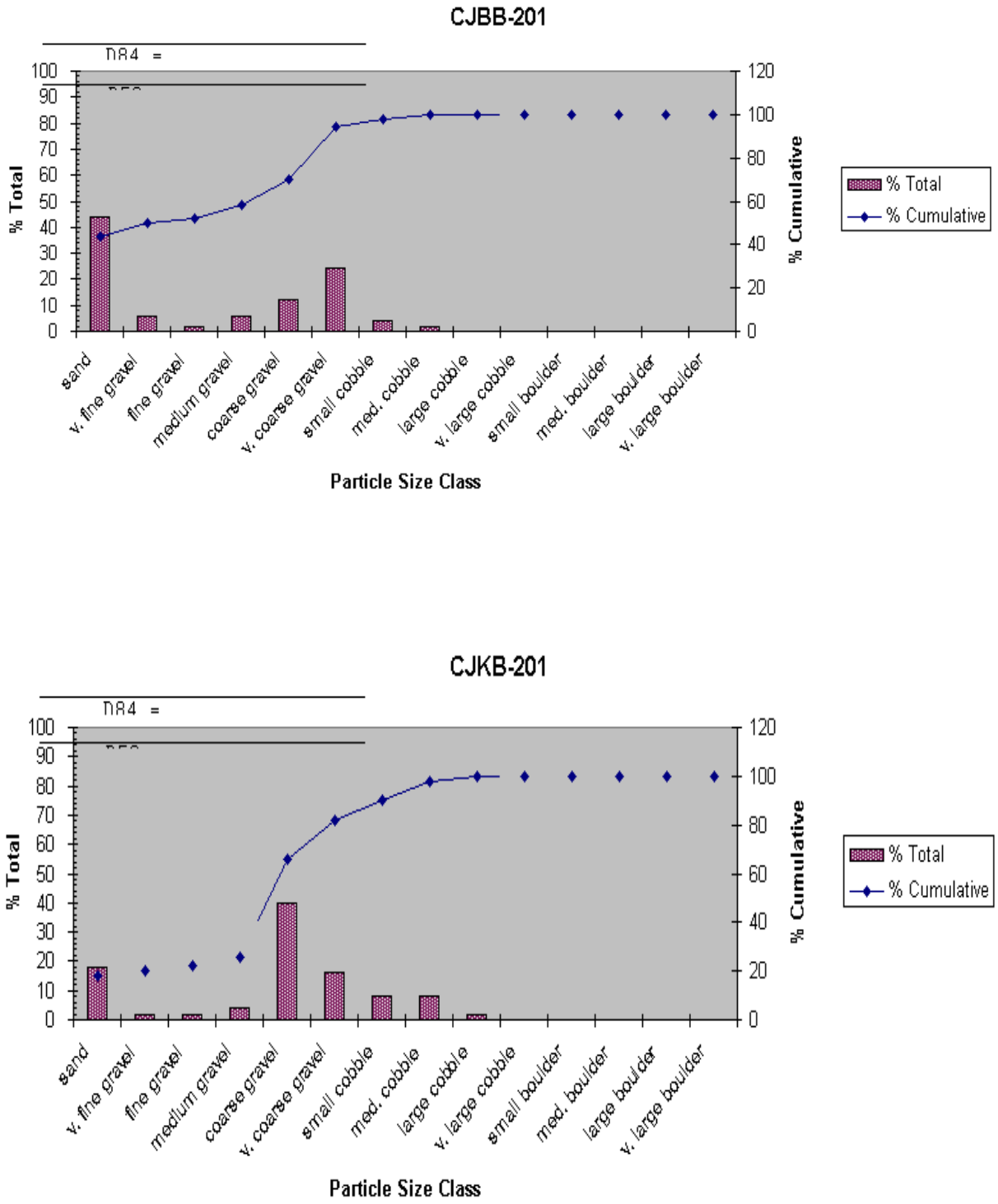


Figure 10. Riffle Particle Size Distributions for the Buck Branch and Ken Branch Monitoring Stations, 1996.

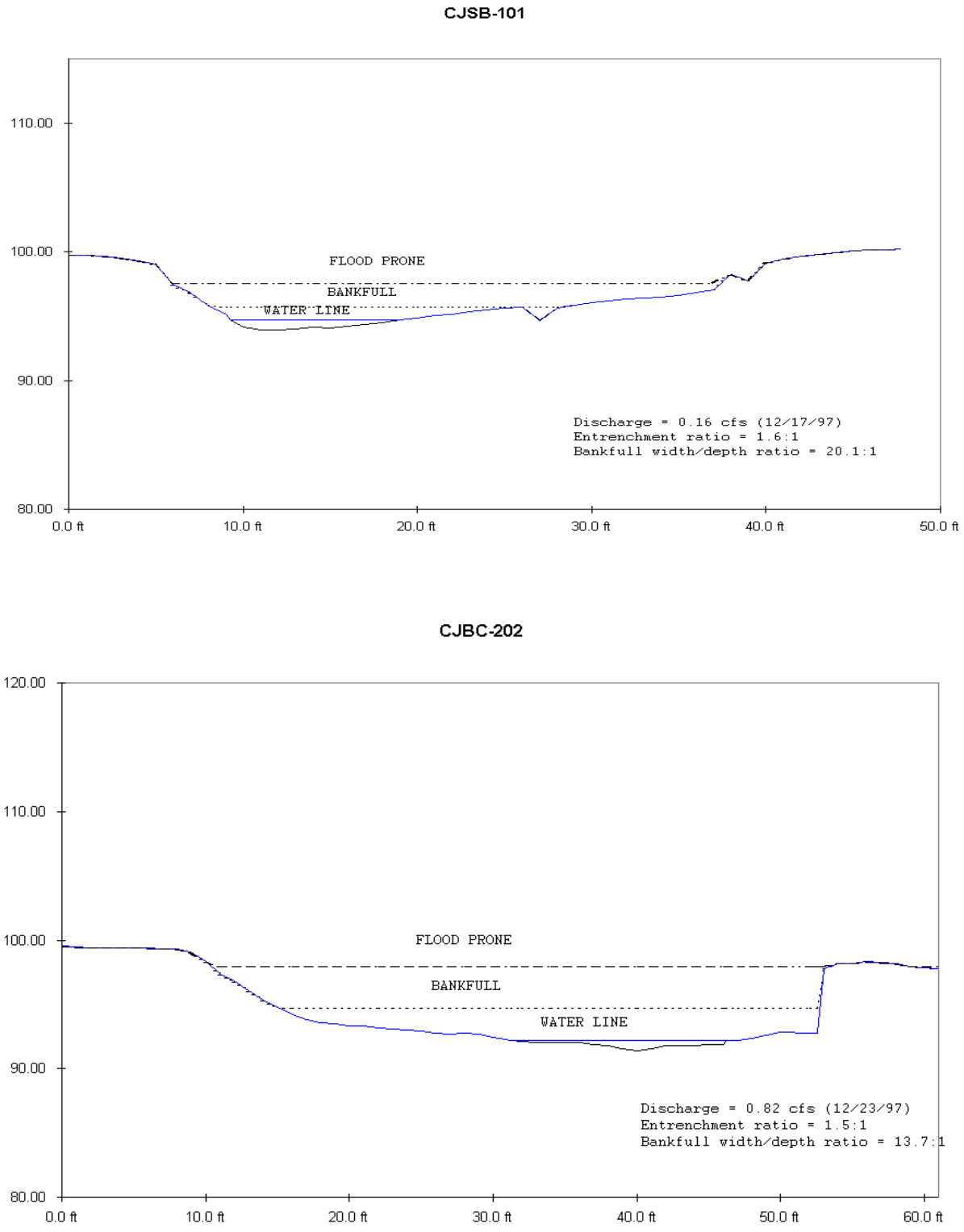


Figure 11. Cross Sections at Snakeden Branch and Booze Creek Monitoring Stations, 1996.

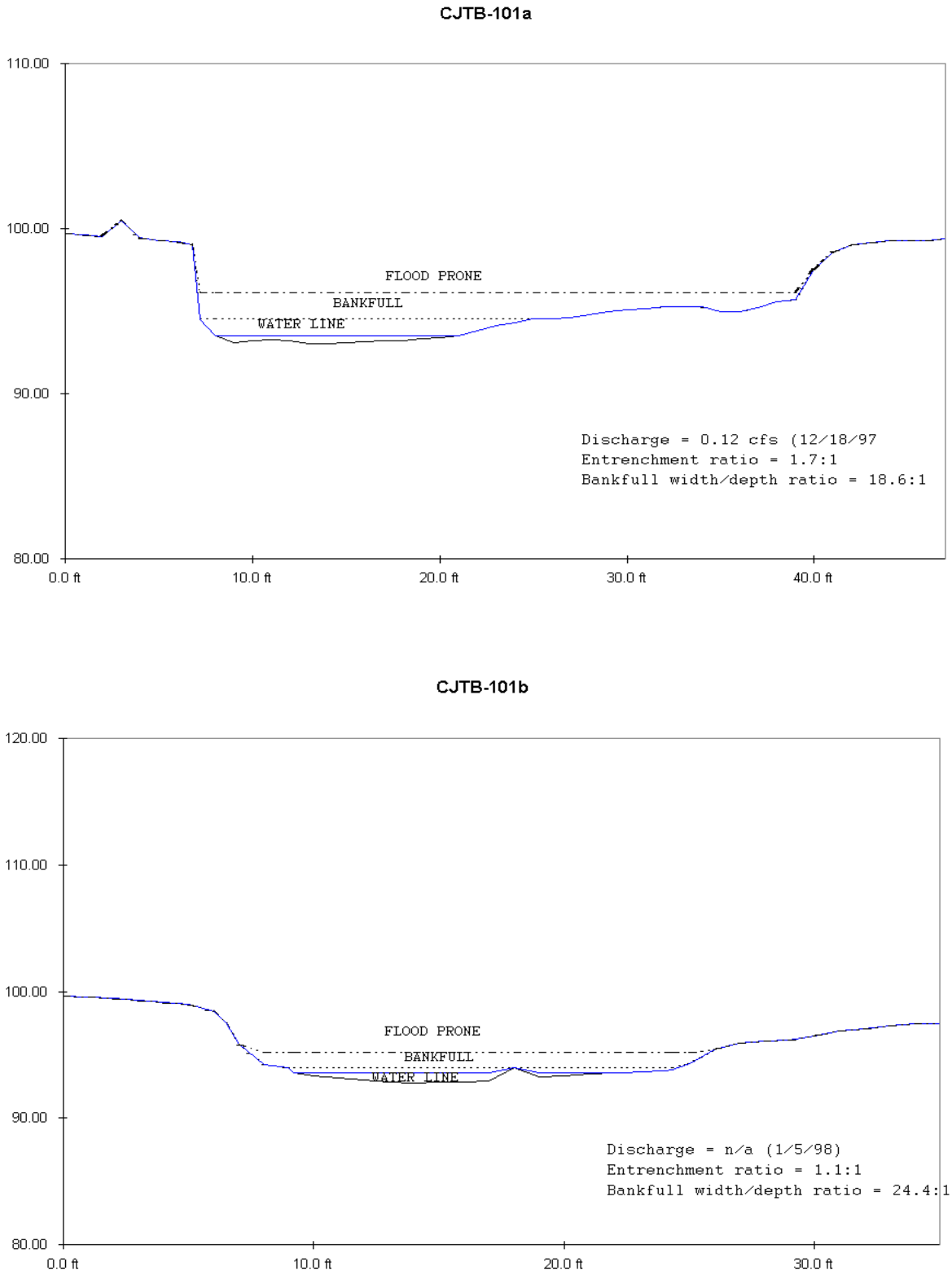


Figure 12. Cross Sections Surveyed at Thomas Branch Monitoring Stations, 1996.

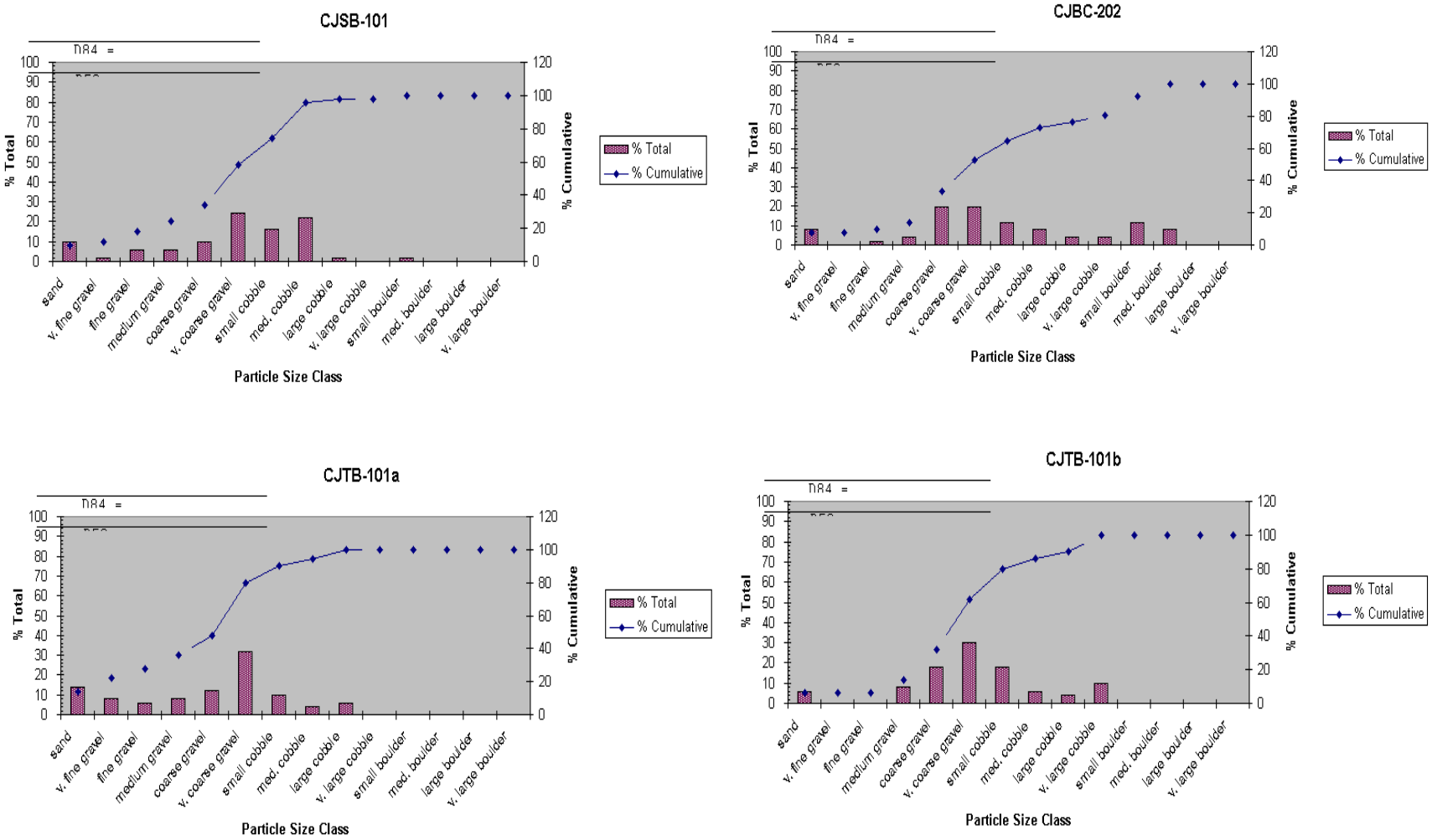
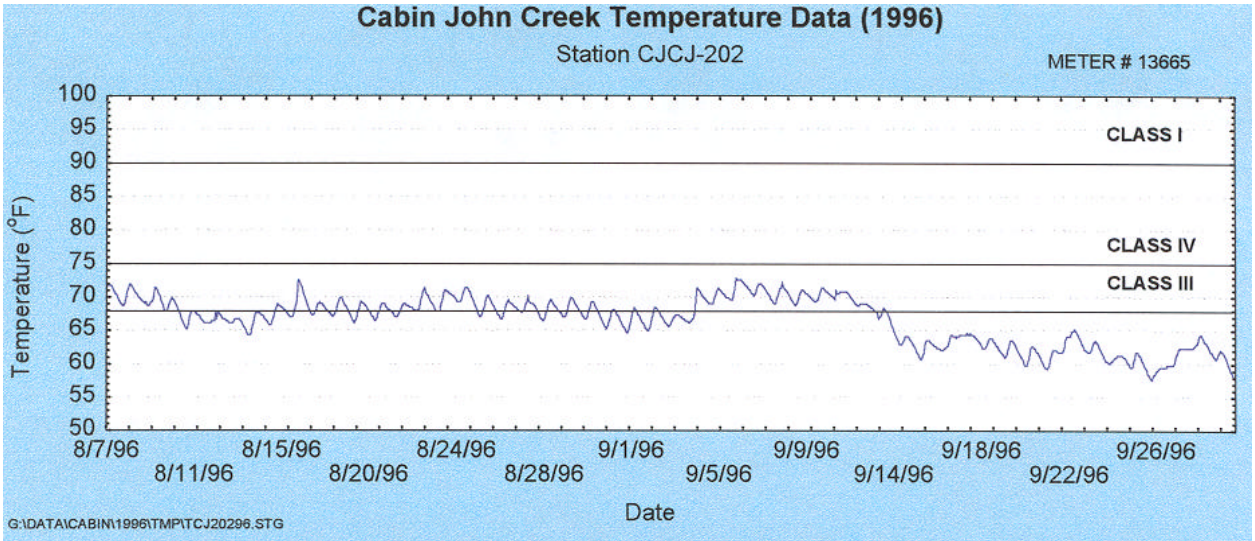
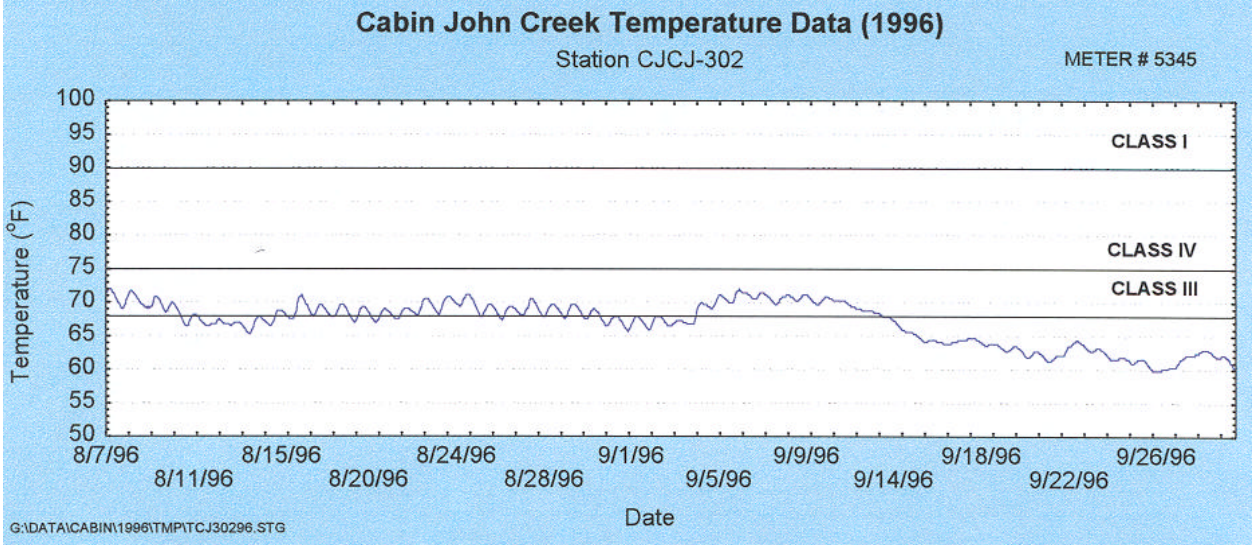


Figure 13. Riffle Particle Size Distribution for Snakeden Branch, Booze Creek, and Thomas Branch Monitoring Stations, 1996.





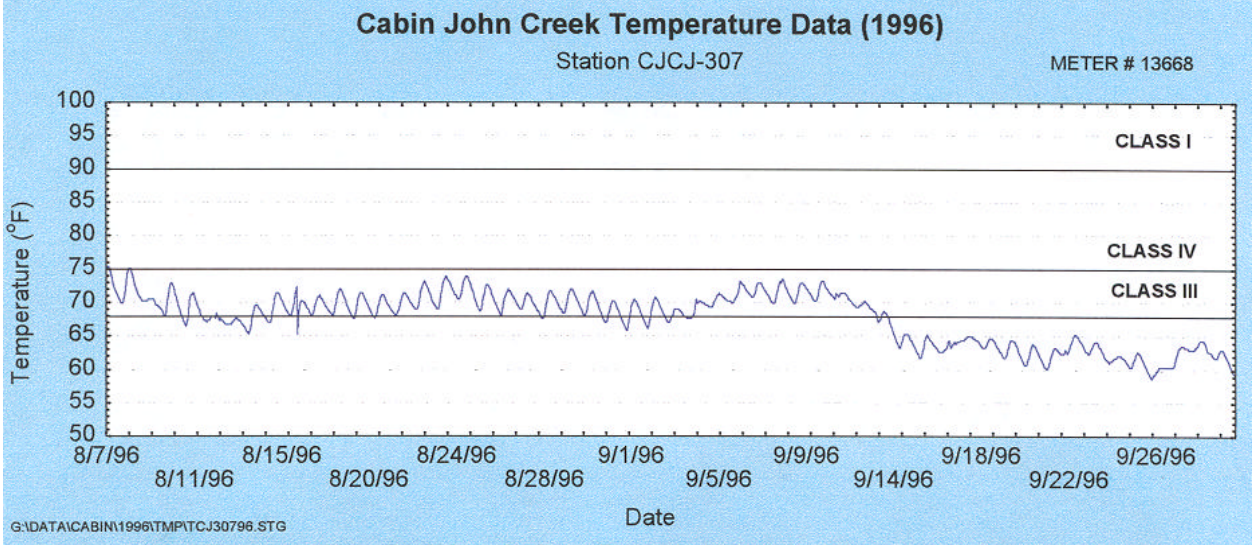


Figure 14. Cabin John Creek Water Temperatures for August to September, 1996.

While there is a large amount of sediment moving within this stream system, it is originating from within the stream channel itself. The watershed is largely built out, there have been no large contributions of new sediment to this stream. The sediment was observed to be of coarser sandy material, depositional in nature. The entrenched stream channels prevent all but relatively rare storm events to access the flood prone areas and deposit excess sediment amounts. Relatively frequent storms are contained within the stream channel, the erosive velocities of these storms accelerate the erosion of the stream banks. This depositional sediment also settles in riffle areas impairing the limited substrate as suitable habitat for benthic macroinvertebrate populations Analysis of the biological condition/habitat condition relationships for both the benthic macroinvertebrate and fish communities have shown that impairment from other than habitat stressors alone are likely to have occurred in upper Thomas Branch and upper Booze Creek. Follow up investigative field work will begin in these subwatersheds to determine the likely cause(s) of impairment.

Indications of probable nutrient enrichment was only observed in the Bucks Branch subwatershed (CJBB201). The fish community was assessed as excellent (i.e, comparable to a fish community found in a reference stream. The benthic community was assessed as fair. Habitat assessments during both periods scored the habitat in the low good range. Elevated nutrients could maintain an abundant community of tolerant benthic macroinvertebrates. The abundant benthic macroinvertebrate community would support the insectivorous fish component of the fish community. Insectivorous fish tend to be more sensitive species than more tolerant fish with a generalist feeding strategy.

The Maryland Department of the Environment (MDE) is presently listing the Cabin John Creek watershed (Basin seq. 02140207) as a water quality limited segment in the 1996 303(d) list prepared by Waterbodies are included on the MDE 303(d) list for which..”required technology based pollution controls are insufficient to meet water quality standards.” It was assigned low priority because the State believes the “impairments may be corrected though the implementation of the high priority Tributary Strategies or through other routine regulatory and voluntary programs currently underway.” Low priority also “reflects the fact that the information supporting the listing may not be reliable and that the impairment may be very localized within the segment.”

MDE indicates that the substances causing the impairment are nutrients and suspended sediments, with the sources being nonpoint and natural. The current schedule MDE has proposed to draft a total maximum daily load (tmdl) for this segment is 1997 to 2000.

DEP’s analysis of the monitoring data for this watershed report does not support listing the entire watershed as a water quality limited segment where the substances causing the impairment are nutrients and suspended sediments. The only segment observed to have a possible nutrient enrichment problem was in Bucks Branch. No suspended sediment impaired segments were found. Depositional sediment is a problem in Cabin John, however, the sediment source is the stream bank and channel itself.

Solutions to the degraded stream channel condition and the uncontrolled runoff must be addressed if the condition of the Cabin John watershed is to be improved. As noted in the Montgomery County Stream Protection Strategy (Rowe et al. 1998)), ..."an action plan is scheduled to begin in 1999 to identify goals and target capital improvement projects and stream restoration needs" for this watershed. Funding for a supporting watershed feasibility/planning study is included in the adopted Montgomery County FY's 1999 to 2004 Capital Improvement Program (CIP).

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Rosgen D.. 1996. Applied River Morphology, Wildland Hydrology, Pagosa Springs, Colorado.

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